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Ruffed Grouse Status, Hunting, and Response to Habitat Management in Missouri

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Ruffed Grouse Status, Hunting, and Response to Habitat Management in Missouri

Eric W. Kurzejeski and Frank R. Thompson, III

Ruffed grouse (*Bonasa umbellus*) have an interesting history in Missouri. Grouse have ranged from a common bird to one near extirpation, and have been the focus of an extensive, long-term, restoration effort. Historical accounts indicate ruffed grouse were present throughout Missouri and common in some localities until 1900. By the early 1930's, grouse were reported in only 19 counties and probably totaled fewer than 100 birds (Bennitt and Nagel 1937). Grouse continued to decline into the 1950's, though it is doubtful they were ever completely extirpated (Lewis *et al.* 1968). An early effort at grouse restoration using game-farm reared birds failed in the early 1940's. Based on improved forest habitat conditions, however, the Missouri Department of Conservation began a second restoration effort in 1959 in central Missouri. Subsequent releases followed, and a large-scale restoration effort began in 1978 and was completed in 1996. Long-term population monitoring was initiated in two areas within the initial release zone: the Thomas S. Baskett Wildlife Education and Research Center in 1962 and the Daniel Boone Conservation Area in 1974. Missouri's first contemporary grouse-hunting season began in 1983 (Hunyadi 1984).

A detailed account of historical grouse abundance, early restoration efforts, habitat characteristics and use at release sites, and restoration strategies is presented by Hunyadi (1984) and Kurzejeski *et al.* (1987). We provide information on the current status of ruffed grouse in Missouri. We summarize recent restoration efforts that have completed the grouse restoration program, present information on grouse abundance and trends from short- and long-term monitoring at release sites, review ruffed grouse hunting in Missouri, and examine case studies of grouse response to habitat management on the Baskett Center and the Boone Area.

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RESTORATION

The ruffed grouse restoration program in Missouri covered a span of almost 40 years. Restoration was dependent both on sources of grouse and on availability of suitable habitat in the form of early-successional forest. Restoration was begun in 1959 and completed in 1996, with 5,366 grouse released on 78 sites in 37 Missouri counties (fig. 1, appendix A). Most restoration attempts were successful in establishing breeding grouse populations. Releases conducted during the past 5 years in southwestern Missouri are still considered experimental because long-term monitoring will be necessary to establish their ultimate fate. The xeric conditions found throughout most of southwestern Missouri will likely limit the potential for population establishment because of their effect on overall forest productivity, vegetation, and grouse foods.

Except for 101 grouse trapped on three sites in central Missouri during 1978-1980, all grouse were acquired through trade agreements with other States. Priority was placed on acquiring grouse from States at similar latitudes to Missouri; the largest source of birds was Indiana (appendix A). However, given the limited availability of grouse from the Central Hardwood States, releases were also made using grouse from more northern latitudes including southern Minnesota, Michigan, and

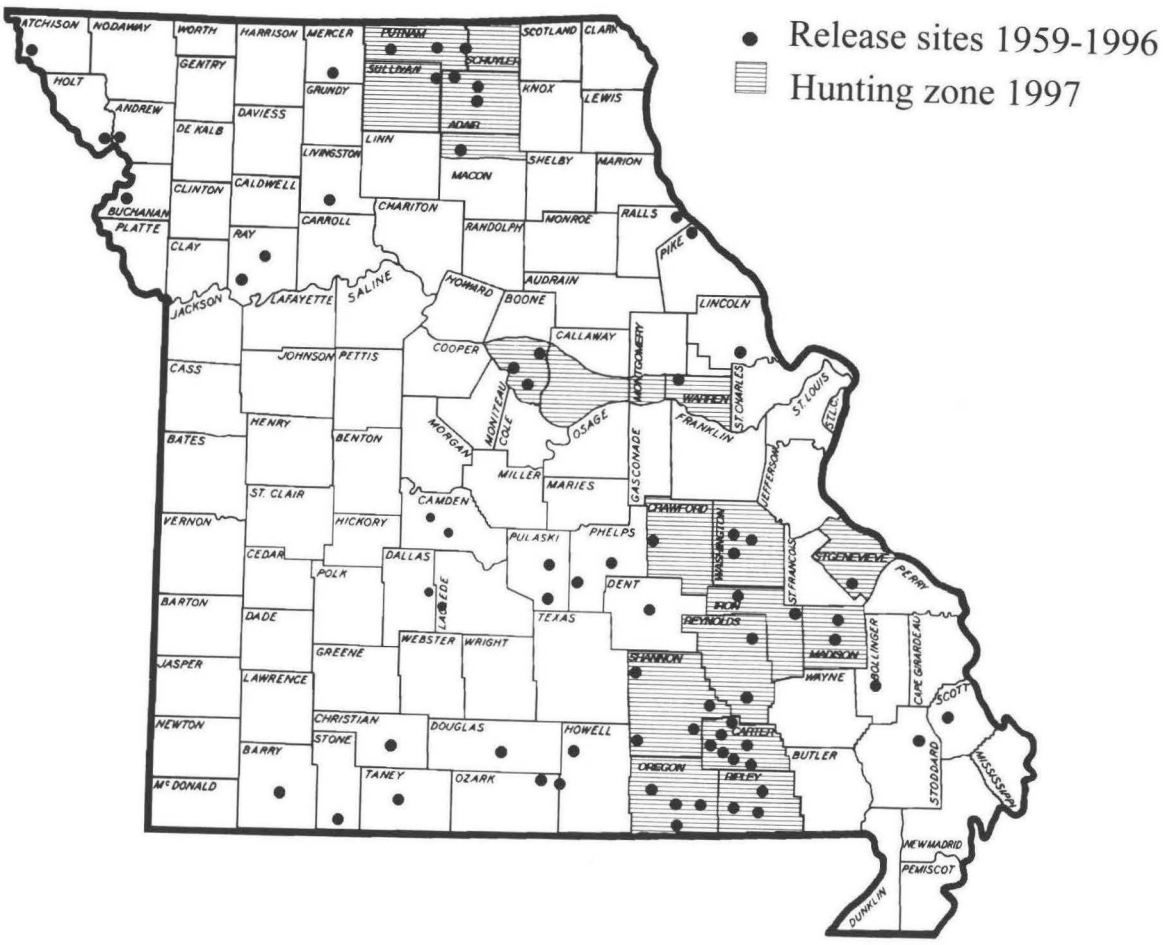

Figure 1.—*Distribution of ruffed grouse release sites and ruffed grouse hunting zones in Missouri.*

Wisconsin. The primary method used to acquire ruffed grouse was to trade wild turkeys (*Meleagris gallapavo sylvestris*) for ruffed grouse. Typically, Missouri was responsible for trapping and transport of turkeys, while the cooperating State was responsible for the capture and transport of ruffed grouse. During the last 4 years of the restoration program, Missouri Department of Conservation (MDC) staff conducted trapping in southern Minnesota. Trade ratios were two to three grouse per turkey. Releases were conducted from September through October, often with the assistance of staff from cooperating agencies such as the USDA Forest Service. On average, 55 grouse were released on a site in a year (range 6 to 116), and some sites received releases in consecutive years (appendix A). Sex ratios were kept as close to 60 percent male 40 percent female as possible. Ratios were skewed towards males because they made up the greatest portion of grouse received in trade, presumably due to sex-related differences in trap vulnerability.

Release Site Selection

Between 1959 and 1985, release sites were selected based on biologists' knowledge of existing habitat conditions and potential for long-term forest management (Hunyadi 1984). In 1986, the MDC developed a comprehensive Ruffed Grouse Species Management Plan that guided restoration activities during the remaining 10 years of the program (MDC 1986). Selection of release sites, under plan direction, was based on systematic surveys of forest habitats using fixed wing aircraft, to identify the distribution and extent of early-successional forest. Locations of potential grouse

habitat were plotted on county-level forest cover maps, and selection of potential release sites was then based on a variety of factors including land ownership, forest management history, and habitat quality and quantity. Systematic surveys to locate potential release sites also provided perspective on the scale necessary to meet restoration objectives. Over 90 percent of grouse releases were made on natural resource agency lands. The greatest factor limiting releases on private land was the inability of the MDC to ensure ongoing, long-term habitat management to provide the early-successional habitat needed by ruffed grouse.

Evaluation of Grouse Releases

Beginning in 1985, all new releases were monitored 1, 3, and 5 years after release by conducting spring drumming counts on standardized 2-mile routes. Routes were conducted on three mornings during the period April 1-21, resulting in estimates of the total number of drumming males detected on the route (appendix B). Before 1985, monitoring of release sites varied; drumming routes were conducted on some sites annually and on other sites sporadically and opportunistically based on the interests of cooperating agencies and available staff time (Hunyadi 1984). In 1986, a subset of 10 release sites was selected for long-term population monitoring based on existing data, geographical distribution, and degree of forest management activities. Monitoring on these sites is conducted annually by MDC staff and cooperating agencies to provide site-specific long-term trends in grouse abundance.

Abundance and Population Trends

Ruffed grouse densities resulting from restoration efforts have been highly varied, yet generally perceived as successful in establishing populations. However, the long-term ability of populations to persist is still questionable in all but a few cases. Central Missouri has supported ruffed grouse populations for more than 35 years as the result of two releases on the Baskett Center and the Boone Area, 100 miles (160 km) apart, in 1959-1962. Population expansion has occurred across an area >7,500 square miles (19,448 sq km) from these two restoration efforts. Long-term censusing of drumming male grouse occurred on these two release sites. Complete area counts of drumming male grouse (Gullion 1966) have been conducted since 1962 on the entire Baskett Center and since 1974 on a 633 acre (256 ha) section of the Boone Area. The number of drumming male grouse on the Baskett Center has ranged from 2 to 21 or 0.1 to 0.92 drummers/100 acres (40 ha) and has averaged 0.46 drummers/100 acres (SD = 0.22) (fig. 2). The number of drumming male grouse on the Boone Area has ranged from 2 to 12 or 0.31 to 1.90 drummers/100 acres (40 ha) and averaged 1.25 drummers/100 acres (SD = 0.38) (fig. 2). While these numbers are low, they are comparable to other States in the southern part of the grouse range. The number of drumming grouse commonly ranges from <1 to 3 drummers/100 acres across the States of Georgia, Tennessee, Kentucky, Indiana, and Ohio (Thompson and Dessecker 1997). The number of grouse in oak forests in northern States may also be comparable. The mean number of drumming grouse over a 25-year study in Stone County, Wisconsin, was 1.27 drummers/100 acres (McCaffery *et al.* 1996).

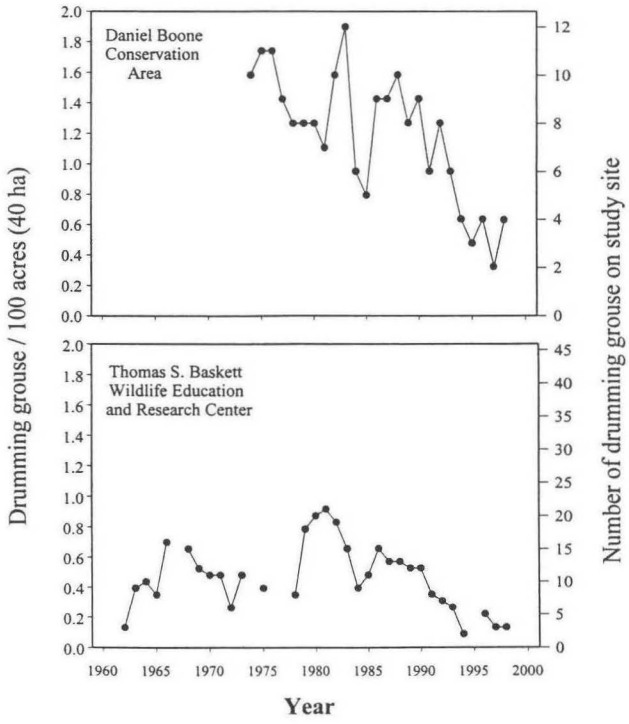

Figure 2.—*Long-term, complete area counts of drumming ruffed grouse on the Thomas S. Baskett Wildlife Education and Research Center and the Daniel Boone Conservation Area in central Missouri, 1962-1998.*

While grouse persist and in some years are locally abundant in central Missouri, the few additional release sites for which data are available over a 20- to 30-year period suggest less optimistic results. In 1963 and 1964, grouse were released on the Carmen Springs Wildlife Area in Howell County in southern Missouri. Drummer numbers were comparable to those in central Missouri for the first 10 years post-release, but, by 1985, the last year a drumming survey was conducted in the area, only one grouse was heard on the 2-mile drumming route. Similarly, a release in 1973 on the Anderson Wildlife Area in northeast Missouri showed initial post-release densities of drumming males that were similar to those in the established populations across the Central Hardwood States (Kurzejeski 1979). Twenty-four years later, grouse can still be found on the release site, but the number of drummers has declined—only one was located on the drumming route in 1997. Changes in habitats due to succession may have resulted in poor quality habitats on these areas and lower grouse numbers.

Monitoring of releases conducted in the late 1970's and early 1980's suggests similar variability in grouse abundance. Sixteen grouse releases since 1980 were monitored by spring drumming routes for 10 to 15 years post-release. These routes showed both site-specific and regional differences in relative grouse abundance. Spring drumming routes were conducted at 10 sites in the Missouri Ozarks where grouse were released from 1979 to 1983. These routes had a similar trend of declining numbers of drumming males resulting in a mean of <0.5 (range 0 to 4) grouse per 2-mile (3.2 km) route, 10 years post-release (fig. 3). Similar results have been noted in northern Arkansas (Infield and Widner 1996). Grouse were released at the Mineral Hills Conservation Area and Sugar Creek Conservation Area in north-central Missouri in 1984 to 1986. Drumming routes at these sites showed initial declines in drummer density, but densities remained much higher than in the Ozarks (fig. 4). Ten years after release, the number of drummers per 2-mile route was 4 and 10 drummers on the Mineral Hills and Sugar Creek Conservation Areas, respectively, in 1996. Releases in the northwestern portion of the State on the Monkey Mountain Conservation Area and private lands in the Millville area are less promising. Monitoring of two releases made during 1983-1984 in this highly fragmented landscape suggests that grouse were not able to persist over a 10-year period (fig. 4). However, verified reports of grouse occurred in 1996 on one of these two sites, suggesting a low-density population may exist.

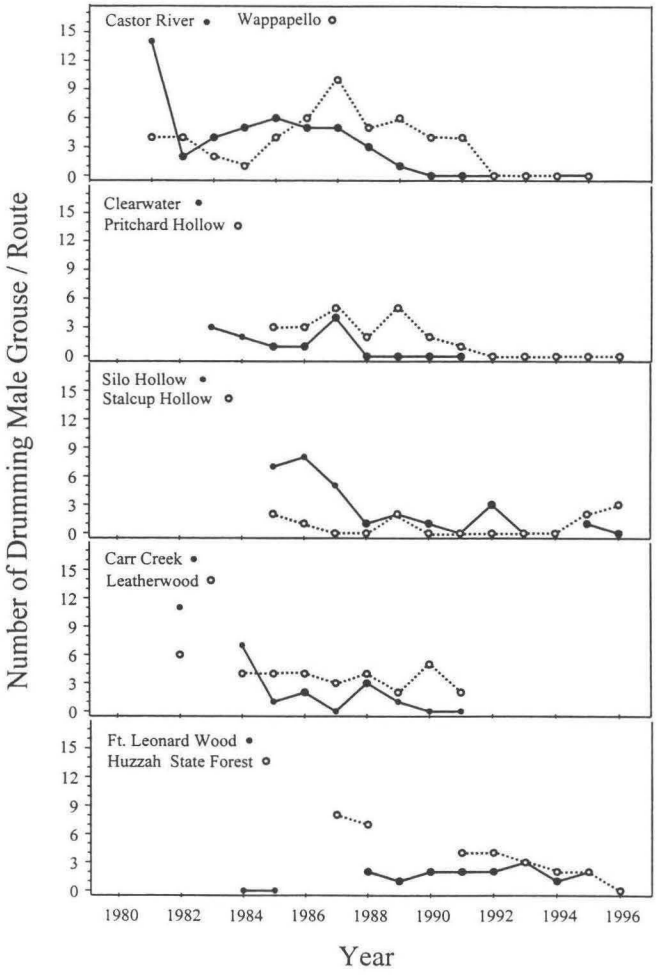

Figure 3.—*Number of drumming ruffed grouse/ survey route at 10 release sites in the Missouri Ozarks.*

While grouse densities are generally low and often variable following releases (figs. 3, 4; appendix B), abundance does not differ greatly from other States in the southern portion of the ruffed grouse's range. Because many of these populations were created by releases, and in some cases widely separated from other populations, the long-term viability of these populations is questionable. Low-density populations are prone to local extinction or extirpation and are dependent on dispersing grouse for recolonization. Ruffed grouse are

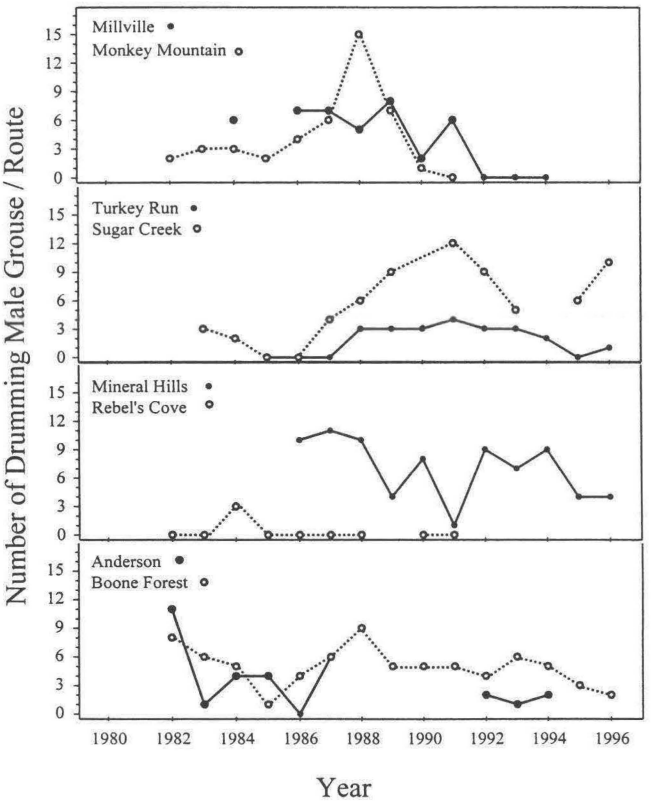

Figure 4.—*Number of drumming ruffed grouse/ survey route at eight release sites in northern Missouri.*

generally good dispersers and frequently colonize successional or ephemeral habitats. Habitat fragmentation has not necessarily limited dispersal movements in northern Missouri (Kurzejeski and Root 1989). At some scale, however, low habitat connectivity and low-density populations could result in extirpations and the absence of grouse in some parts of their Missouri range for short or even extended periods.

A confounding factor in determining the success or failure of restoration efforts is the inability to adequately quantify range expansion. Much anecdotal evidence suggests grouse may be found in suitable habitats some distance from the release sites in areas where drumming surveys have failed to detect grouse at the release site. For example, five drummers were found on a route in Carter County, Missouri, run for the first time in 1995, and located only 2 miles from a release site where no grouse had been heard for 2 years. Similarly, no grouse were located for 5 years (1990-1994) on another release site in Carter County, but two and three grouse, respectively, were located on the same route in 1995 and 1996. If habitat quality declines at release sites, grouse will likely disperse to more suitable habitats elsewhere.

Two recent activities were begun in an effort to provide more information on population distribution. The first relies on volunteers, all members of the Missouri Chapter of The Ruffed Grouse Society, to conduct spring drumming routes across portions of the established range. Participants agree to establish routes in areas containing suitable habitat, survey the routes at least three times during the month of April, and conduct the surveys for 5 years.

The second attempt to monitor grouse abundance and distribution will incorporate sightings of ruffed grouse into existing hunter surveys conducted by MDC. These surveys rely on hunter groups (e.g., bowhunters, spring turkey hunters) to report grouse sightings, which then can be used to construct indices of abundance (e.g., sightings/hour hunted) as well as to provide anecdotal information on distribution.

HUNTING

Missouri initiated a ruffed grouse hunting season in portions of four central Missouri counties in 1983 (Kurzejeski *et al.* 1987). Between 1983 and 1995, all grouse hunters were required to purchase a grouse hunting permit, primarily to provide a basis from which harvest and hunting pressure surveys could be conducted. Each hunter who purchased a permit was mailed a hunter record form before the season and asked to record information about each hunt. Those not returning the form 2 weeks after the season closed were sent a reminder notice, including a post card on which they were asked to report their estimate of hours hunted, flushes, and harvest. Data from hunter record forms and summary post cards were combined to construct estimates of harvest and hunting pressure. In 1983, 72 percent of those purchasing a permit returned survey information. By 1992, only 32 percent of permit buyers responded to the survey. In 1993, response was so low that meaningful estimates of harvest and hunting pressure could not be constructed from survey information. Therefore, we present data for the period 1983-1992.

Initial season dates were October 15-December 18, and the season was extended to January 15 in 1987. The daily bag limit has been two grouse per day since the season began. Four additional counties in the Missouri Ozarks were opened to hunting in 1989 and five in 1992; six counties, including four in northern Missouri, were opened in 1993. Presently a total of 19 counties are opened for grouse hunting (fig. 1).

Almost 3,000 hunters purchased permits in 1983, but hunter numbers declined dramatically in 1984 and steadily thereafter. In 1995, the last year of permit sales, only 320 permits were purchased. On average, only 60 percent of those who purchased a permit hunted. Opening new counties to hunting and extending the season did not result in an increase in hunter numbers. Despite the low number of grouse hunters, hunter success as measured by flush rates (hours/grouse flushed) ranged from 1.2 in 1987 to 3.6 in 1984 (table 1) and were comparable to those in other portions of the southern grouse range (Backs 1984). The mean flush rate over the 10-year survey period was 2.1 hours/flush. Estimated harvest, adjusted for non-response, ranged from 262 grouse in 1987 to 47 in 1984. After the season was extended to January 15 in 1987, hunter effort and harvest during the approximately 1-month extension (33 days) was almost equal to (and exceeded in 1988) that occurring during the first 65 days of the season (table 2). Late season hunting may have provided better hunting conditions and had less competition because of few other hunting opportunities.

Hunter records provided both hunting pressure and minimum harvest estimates from selected tracts of State land in central Missouri. Over 45 percent of hunting pressure occurred on State lands, and the greatest effort was concentrated on the Boone Area. Minimum harvest estimates on the Boone Area and other State lands are presented in table 3. In 1987, a minimum of 48 grouse were harvested on the 3,520-acre Boone Area (1.36 grouse/100 acres). This declined to 6 (1 grouse/586 acres) in 1991. Assuming 1.4 drummers/100 acres and 6 to 7 grouse/100 acres in the fall populations, the 1987 harvest on the Boone Area was approximately 21 percent of the fall population. This was well within generally accepted levels of harvest.

Table 1.—*Annual statistics for Ruffed grouse hunting in Missouri, 1983-1992*

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Reported harvest	151	51	42	84	221	123	199	74	55	63
Adjusted harvest	173	58	47	93	262	146	251	133	107	138
Permits sold	2,900	898	660	648	680	880	757	543	488	450
Number of hunters	1,779	620	365	325	403	437	487	339	306	282
Hours/Flush	3.0	3.6	2.6	1.6	1.2	1.7	1.5	1.7	2.2	2.2
Total flushes	1,278	1,003	944	1,556	2,714	1,960	2,632	1,011	738	581

Table 2.—*Ruffed grouse hunting statistics for early and late hunting season[1] in Missouri, 1987-1988*

	Early (65 days)				Late (33 days)			
	1987		1988		1987		1988	
Variable	n	%	n	%	n	%	n	%
Hours	1,063	55	1,273	56	881	45	996	44
Flush	1,052	59	758	50	743	41	745	50
Bag	103	63	48	48	60	37	52	52

[1]early = Oct 15-Dec 18; late = Dec 19-Jan 15.

Table 3.—*Ruffed grouse harvest statistics on selected Missouri Department of Conservation, Conservation Areas (C.A.) in Central Missouri, 1983-1992*

	Daniel Boone C.A.			Little Lost Creek C.A.			Danville C.A.			Reifsnider C.A.		
Year	Hours	Flush	Harvest	Hours	Flush	Harvest	Hours	Flush	Harvest	Hours	Flush	Harvest
1983	1,110	571	22	520	207	14	134	53	3	79	104	6
1984	528	179	11	183	34	4	113	10	0	80	18	1
1985	330	167	10	196	64	6	55	41	2	94	28	0
1986	480	387	20	172	83	6	155	26	3	39	20	0
1987	417	423	48	297	238	30	154	107	1	140	103	11
1988	400	222	17	298	188	17	162	74	4	127	25	1
1989	599	453	45	286	241	26	197	60	11	93	49	0
1990	210	90	12	88	29	4	49	22	0	41	11	1
1991	228	68	6	37	9	0	20	3	0	86	20	0
1992	240	103	11	154	85	10	20	1	0	18	4	1

Comparisons of drumming count data from the Boone Area, which was heavily hunted, and from the Baskett Center, which was not opened to hunting, provide some insight into the relationship between harvest and spring drummer densities. The same trends in grouse abundance were observed on both areas over time (fig. 2), and densities were generally lower on the non-hunted Baskett Center. While these data are limited to two case studies, they provide evidence that hunting was not the predominate factor affecting grouse abundance.

RESPONSE TO HABITAT MANAGEMENT

Two case studies of ruffed grouse population response to forest management are being conducted in Missouri. Both study sites, the Baskett Center and the Boone Area, were original grouse release sites (appendix A). Grouse abundance on both sites is monitored through complete area drumming counts that are conducted each April. Observers systematically search each site on repeated mornings and map locations of individual drumming male grouse. Forest age-classes also were cover mapped on each site, so drumming sites could be assigned to forest age-classes.

Thomas S. Baskett Wildlife Education and Research Center

In 1982, a long-term study was initiated on the Baskett Center to determine the effects of clearcutting on forest wildlife. The Center was composed predominately of mature oak-hickory forest (65 percent), mixed stands of sapling- and pole-size eastern redcedar and hardwoods (21 percent) and old fields in various stages of succession (8 percent). The study site is divided into two treatment areas totaling 418 ha and three control areas totaling 510 ha. From 1982 to 1988, 11 mature-forest stands ranging from 0.7 to 4.5 ha were clearcut on the treatment areas. In 1997, 2 percent of the total area, or 4.5 percent of the treatment area, was regenerating hardwood seedling- and sapling-size stands.

Surveys of drumming male grouse have been conducted on the Baskett Center since 1962 by the complete area count method (Gullion 1966). We classified all drumming sites since 1962 as in treatment or control areas and plot these by year (fig. 5). We also classified all drumming sites since 1982, when forest management was initiated, by major habitat type and report the percentage of drumming sites each year in hardwood pole and sawtimber, sapling and pole-sized cedar and hardwoods, and regenerating seedling-sapling-size hardwoods (fig. 6).

There was a change in habitat use on the Baskett Center over time in response to habitat management. Use of regenerating seedling-sapling stands by drumming males increased from 0 to $\geq$ 50 percent, while use of pole-sawtimber and cedar-hardwoods has decreased. Drumming sites were located in seedling-sapling stands beginning 6 years after

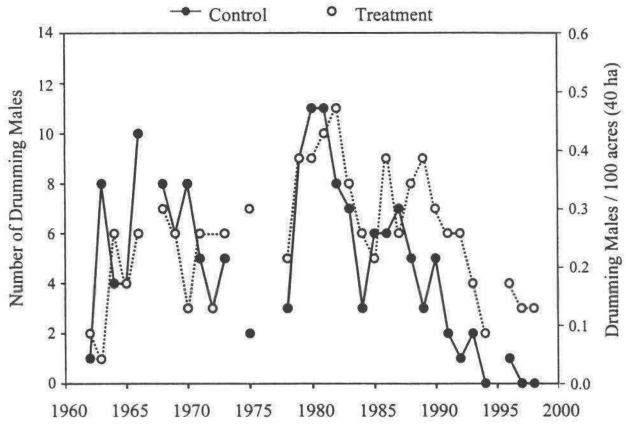

Figure 5.—*Number and density of drumming ruffed grouse in control and treatment areas on the Thomas S. Baskett Wildlife Education and Research Center in central Missouri. Eleven stands in the treatment area were regenerated by the clearcut method between 1983 and 1988.*

stands were regenerated by clearcutting. Although as many as 100 percent of drumming males in a year were in seedling-sapling stands, seedling-sapling stands composed only 2 percent of the study area.

Numbers of drumming males have declined on the Baskett Center over the last 15 years, complicating interpretation of response to habitat management. Comparisons of control and treatment areas on the Baskett Center, however, indicate a positive response to clearcutting. The density of drumming grouse has been consistently greater in treatment areas (clearcut) than control areas (fig. 5).

Daniel Boone Conservation Area

Long-term data are available on both the density and distribution of drumming males on the Boone Area since 1974. Forest age-classes on the 256-ha compartment six of the Boone Area in 1974 were predominately poletimber and sawtimber stands (97.4 percent), with sapling stands making up only 0.3 percent of the area (Hunyadi 1978). Grouse habitat potential in compartment six was determined by Hunyadi (1978) based on intensive surveys of grouse use and measures of forest stand structure. Poorly stocked oak-hickory stands, subjected to both a white oak stave bolt cut in 1959 and a red oak diameter limit sale in 1967,

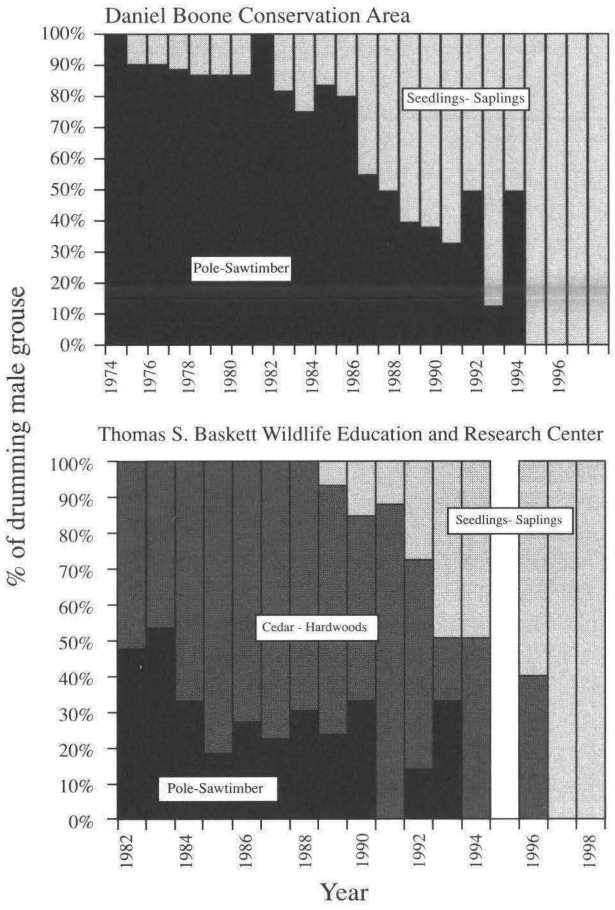

Figure 6.—*Percent of drumming male grouse activity centers, by forest-stand type, on the Thomas S. Baskett Wildlife Education and Research Center and the Daniel Boone Conservation Area in central Missouri, 1974-1997.*

and bottomland hardwood stands were most frequently used by grouse (Hunyadi 1978). The regenerative response from selection cuts provided understory woody stem densities within the range of those reported to be selected by ruffed grouse in other portions of the southern range. Similarly, bottomland hardwood sawtimber stands had lower stocking levels and, therefore, a more dense understory than upland sawtimber stands. Hunyadi (1978) estimated that 16 percent (41.7 ha) of the 256-ha compartment provided low- to medium-quality habitat for ruffed grouse.

In 1980, a 47-acre stand (7 percent of the compartment) was regenerated by the clearcut method to provide additional early-successional forest. Drumming male grouse began using the regeneration cut in 1985. Densities of drumming males between 1985 and 1997

ranged from 2 in 1997 to 10 in 1988 and averaged 6.4 grouse (fig. 2), and decreased over time concomitant with a decrease in potential habitat from 16 to 7 percent of the area. The quality of habitat decreased in stands that provided secure drumming cover in the mid-1970's and early 1980's as a result of succession. A shift in location of drumming sites also occurred; by 1994, all drummers were found in the 47-acre seedling-sapling stand created by the clearcut in 1980 (fig. 6).

We believe that long-term grouse abundance on the Boone Area can be enhanced both by increasing the percentage of area in early-successional forest and by improving distribution and connectivity among stands of regeneration and saplings. The current Boone Area management plan, completed in 1996, calls for regeneration of an additional 12 percent of this compartment in 1998. In addition, connecting corridors will be established among all regeneration and sapling stands. Within these corridors, located mainly along lower slopes and drainages, basal area will be reduced to <30 square feet/acre to encourage a dense woody understory. Grouse abundance and distribution will continue to be monitored using drumming surveys.

CONCLUSIONS

Ruffed grouse restoration in Missouri has met two major objectives defined at the onset of the program. The first was to restore grouse to suitable habitats across the State, and the second was to provide opportunities for grouse hunting. Grouse densities in Missouri will likely, on average, remain at low densities that are comparable to, or even lower than other States in the southern portion of the ruffed grouse's range. Grouse numbers may be lower in Missouri than in other southeastern States because Missouri is on the southwestern border of ruffed grouse range, and rainfall and forest productivity are generally lower than to the east. It is not clear to scientists why grouse in southern portions of their range occur at lower densities than in northern parts of their range, but it is likely due to differences in climate and forest types, such as a lack of aspen (*Populus* spp.) (Thompson and Dessecker 1997). Grouse can be locally abundant in Missouri and will always be most abundant where appropriate habitats are present, particularly young dense forest cover.

Grouse numbers have consistently declined after releases to a low number or even no drummers/route. We believe that these declines occur because of dispersal or mortality (Kurzejeski and Root 1988) and that grouse numbers reach an equilibrium density that local habitat can support. In some instances where routes have declined to zero, grouse have been detected nearby in more suitable habitat. We believe there is no evidence that additional releases would have a long-term effect on grouse numbers. One potential situation where additional grouse releases could benefit grouse populations is where a local population is extirpated because of population fluctuations, and recolonization would take too long because of the distance between populations or because populations are isolated.

It has been difficult to monitor grouse populations in Missouri because of the low density of drumming males. Based largely on anecdotal evidence, we believe males in low-density populations may drum less frequently than males in more abundant populations, further complicating our ability to survey population abundance. More intensive monitoring, such as a greater number of long-term drumming routes, would provide better information on grouse populations. We believe there is reason for continued concern about the status of grouse in Missouri because of generally low densities. Some level of long-term, regionally stratified population monitoring, such as drumming route surveys and complete area counts, would provide valuable population information.

Grouse hunting may never gain substantial popularity in Missouri. Contributing factors are a lack of hunter familiarity with ruffed grouse, low population densities, and the restricted distribution of grouse to early-successional or dense forest habitats. Interest in grouse hunting will likely vary over time as grouse numbers vary locally with changes in habitat availability.

Grouse will be most abundant where there is ongoing habitat management. Case studies at the Boone Area and the Baskett Center demonstrate that grouse prefer young forest stands over other habitats, and grouse numbers are greatest where these habitats are available. In recent years, grouse numbers

have been low, even in the managed portions of these areas. We believe this is largely because young forest habitats, created by regeneration cuts, still represent only a small percentage (<7 percent) of these areas. Thompson and Dessecker (1997) suggest that central hardwood forest 3 to 15 years old provides brood and/or adult cover for grouse. Even under an intensive forest management plan, where timber is regenerated on an 80-year rotation, only about 15 percent of the area will be in stands 3 to 15 years old. By contrast 25 percent or more of a northern landscape, where aspen is managed on a 40-year rotation, can be kept in grouse habitat. The total amount of grouse cover can be increased by managing other successional habitats such as old fields and selectively harvesting riparian forest to increase understory density (Thompson and Dessecker 1997). It is not clear what densities grouse can reach in Missouri because no areas have been monitored and intensively managed for grouse or other early-successional forest wildlife. Most public lands are managed for multiple use and balance the needs of early- and late-successional wildlife, along with other human uses.

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APPENDIX A.—*Ruffed grouse releases in Missouri, 1959-1996*

Area	County	Year	Number	Source
Daniel Boone State Forest	Warren	1959	18	OH
		1960	63	OH
		1961	62	OH
Thomas S. Baskett Wildlife	Boone	1961	39	OH
Research and Education Center		1962	63	OH
		1962	17	IN
Carmen Springs Wildlife Area	Howell	1963	70	IN
		1964	66	IN
Logan Wildlife Area	Lincoln	1965	38	IN
		1966	26	IN
Anderson Wildlife Area	Pike/Ralls	1975	82	WI
		1976	116	WI
DuPont Wildlife Area	Pike	1965	34	IA
		1966	6	IA
		1971	35	MN
		1973	22	MN
		1974	19	MN
Renner Wildlife Area	Boone	1973	15	KY
		1974	18	KY
		1980	27	IN
Castor River State Forest	Bollinger	1978	37	MO
		1979	40	MO, OH, IN
Cardareva	Shannon	1979	77	MO, OH, IN
Leatherwood	Shannon	1979	87	MO, OH, IN
Pulltite	Shannon	1979	14	MO
		1980	62	IN
Panther Hollow	Oregon	1980	46	IN
Hackleton Hollow	Oregon	1980	55	IN
Becky Hollow	Oregon	1980	61	IN
Brickyard Hill Wildlife Area	Atchison	1980	47	WI
Monkey Mtn. Wildlife Area	Holt	1980	56	WI
		1981	11	WI
		1981	24	IN
Honey Creek Wildlife Area	Andrew	1980	39	WI
Rebel's Cove Wildlife Area	Putnam/	1980	57	WI
	Schuyler	1981	56	WI
Peck Ranch Wildlife Area	Carter	1981	85	IN
Wappapello Lake	Wayne	1981	82	IN
General Watkins State Forest	Scott	1981	81	IN
Bluffwoods State Forest	Buchanan	1981	35	IN
		1981	21	WI
Clearwater State Forest	Reynolds	1982	71	IN
White Oak Hollow	Carter	1982	70	IN
Compton Creek	Ripley	1982	70	IN
Dogwood Canyon	Stone	1982	60	IN
Ringer Hill	Stoddard	1982	20	IN
Sugar Creek State Forest	Adair	1982	68	WI
Weldon River	Mercer	1982	43	WI
Crooked River Wildlife Area	Ray	1983	71	WI, MI, IN

(Appendix A continued on next page)

(Appendix A continued)

Area	County	Year	Number	Source
Millville - Hiser Farm	Ray	1983	50	WI, MI, IN
Mineral Hills State Forest	Putnam	1983	77	WI
		1984	11	MI, IN
Locust Creek	Putnam	1983	20	WI, MI
Big Piney River	Pulaski	1983	70	WI, MI
Ft. Leonard Wood	Pulaski	1983	39	WI
Deer Run State Forest	Reynolds	1983	62	IN
Woods Wildlife Area	Crawford	1983	61	IN
Cowards Hollow	Carter	1983	62	IN
Buffalo Creek	Ripley	1983	71	IN
Big Barren Creek	Carter	1983	24	IN
Locust Creek	Putnam	1984	35	WI, MI
Silo Hollow	Carter	1984	55	IN
Turkey Run Creek	Adair	1984	12	WI, MI
Vermillian Hollow	Shannon	1984	39	IN
Brusky Creek	Carter	1984	64	IN
Scott Branch	Washington	1984	88	IN
Hamilton Farm	Livingston	1984	63	IN, WI, MI
Little Barren Creek	Ripley	1984	77	IN
Griffin Hollow	Madison	1985	77	IN
Coldwater Creek	St. Genevieve	1985	80	IN
Hazel Creek	Reynolds	1985	66	IN
Little Lost Creek	Washington	1985	36	IN
McLean Hollow	Reynolds	1985	87	IN
Sharp Farm	Adair	1985	61	WI
Spring Creek Ranch	Sullivan	1985/86	62	WI
Mayse Farm	Macon	1986	65	MI
Juden Farm	Cape Girardeau	1986	35	WI
Ft. Leonard Wood	Pulaski	1986	73	IN
Sugar Creek State Forest	Adair	1986	76	IN
Huzzah State Forest	Crawford	1986	64	IN
Crane Lake West	Iron	1986	43	IN
Henderson Hollow	Iron	1987	102	IN
Hodge/Barren Fork	Dent	1987	66	IN
Hutchison Farm	Carter	1987	20	IN
Dry Creek	Howell	1989	75	IN
Greasy Creek	Douglas	1989	92	IN
Crane Lake East	Iron	1989	33	IN
Garrison/Devreau	Christian	1990	79	IN
Rock Creek	Barry	1990	86	IN
Seligman/Pine Hollow	Barry	1991	68	IN
Mill Creek	Phelps	1991	115	IN
Spring Creek	Phelps	1991	56	IN
Cedar Creek	Taney	1992	63	MN
Winchester Gap	Dallas	1992/93	96	MN
Posperine	Laclede	1993/94	84	MN
Acker Trust Lands	Camden	1994/95	63	MN
Macks Creek	Camden	1996	61	MN

APPENDIX B.—*Numbers of drumming male ruffled grouse detected on drumming route surveys in Missouri at release sites monitored 1, 3, 5 years post-release*

Area	Year of release	No. of Drummers, years post-release		
		1	3	5
Brushy Creek	1984	9	5	4
Cedar Creek	1992	1	0	0
Clearwater State Forest	1982	3	1	4
Coldwater	1985	6	4	10
Compton Creek	1982	7	4	5
Garrison/Devreau	1990	11	4	4
General Watkins State Forest	1981	6	6	4
Greasy Creek	1989	5	4	5
Griffon Hollow	1985	2	11	7
Hazel Creek	1985	8	1	7
Henderson Hollow	1987	8	6	5
Honey Creek	1980	0	2	0
Little Barren Creek	1984	7	6	2
Mayse Farm	1986	4	3	4
McLean Hollow	1985	7	9	11
Panther Hollow	1980	3	1	2
Rock Creek	1990	16	0	7
Scott Branch	1984	6	7	5
Seligman	1991	10	4	1
Spring Creek Ranch	1985	3	6	2
Spring Creek	1991	5	3	1

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Kurzejeski, Eric W.; Thompson, Frank R., III.
1999. **Ruffed grouse status, hunting, and response to habitat management in Missouri**. Res. Pap. NC-333. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 14 p.

Summarizes recent efforts that have completed the grouse restoration program in Missouri. Presents information on grouse abundance and trends from short- and long-term monitoring at release sites. Reviews ruffed grouse hunting in Missouri, and examines two case studies of grouse response to habitat management.

KEY WORDS: Ruffed grouse, Missouri, restoration, hunting, habitat use, population trends, status.

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Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.